## 8.6 DO135

### 8.6.1 Technical Data


| Module ID | DO135 |
|---|---|
| **General Information** | |
| Model Number | 7DO135.70 |
| Short Description | 2003 digital output module, 4 FET outputs 12 to 24 VDC, 0.1 A,<br>screw-in module, Order terminal block TB712 separately! |
| C-UL-US Listed | Yes |
| B&R ID Code | $14 |
| Slot | AF101 adapter module, CP interface |
| **Static Characteristics** | |
| Module Type | B&R 2003 screw-in module |
| Number of Outputs | 4 |
| Design | FET |
| Type | Push/Pull switch |
| Switching Voltage/Supply<br>Minimum<br>Nominal<br>Maximum<br>Protection | <br>11.4 VDC<br>12 - 24 VDC<br>30 VDC<br>Reverse polarity protection |
| Continuous Current per<br>Output<br>Module | <br>Max. 0.1 A<br>Max. 0.4 A |
| Maximum Switching Frequency | 100 kHz |
| Residual Voltage | Max. 0.6 V at 0,1 A |
| Capacitive Load | Max. 20 nF<br>An overcurrent warning is given when switching<br>large capacitive loads |
| Power Consumption | Max. 0.2 W |

| **Module ID** | **DO135** |
|---|---|
| **Protection Characteristics** | |
| Protection<br>Short circuit protection<br>Overload protection | <br>Yes<br>Yes |
| Short Circuit Current | 0.11 - 0.3 A |
| Diagnosis Status for SW Evaluation<br>Overvoltage<br>Undervoltage<br>Overcurrent Monitoring | <br>Us >30 VDC, a voltage >35 VDC for t >5 ms will damage the outputs<br>Us <10.5 VDC<br>Functions with a duty cycle of at least 10 µs |
| **Dynamic Characteristics** | |
| Switching Delay<br>Typical<br>Maximum | <br><2 µs<br>2.4µs |
| **Operating Characteristics** | |
| Electrical Isolation<br>Output - PCC<br>Output - Output | <br>No<br>No |
| Cable Requirement | Shielded cable |
| **Mechanical Properties** | |
| Dimensions | B&R 2003 screw-in module |

### 8.6.2 General Information

The DO135 is a 4 channel output module. The outputs are tristate when switched on. All outputs are activated as a group after the outputs are configured using configuration word 14.

## 8.6.3 Operating Modes

Operating modes can be set separately for each output. The following operating modes are available:

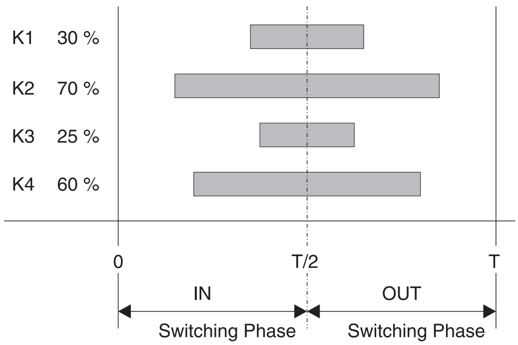
- Normal operation
- Pulse width modulation (PWM)
- TPU operation

### Normal Operation

The outputs are switched on/off.

### Pulse Width Modulation

Output are switched on/off periodically. Pulse width ratio, period duration and resolution can be set.



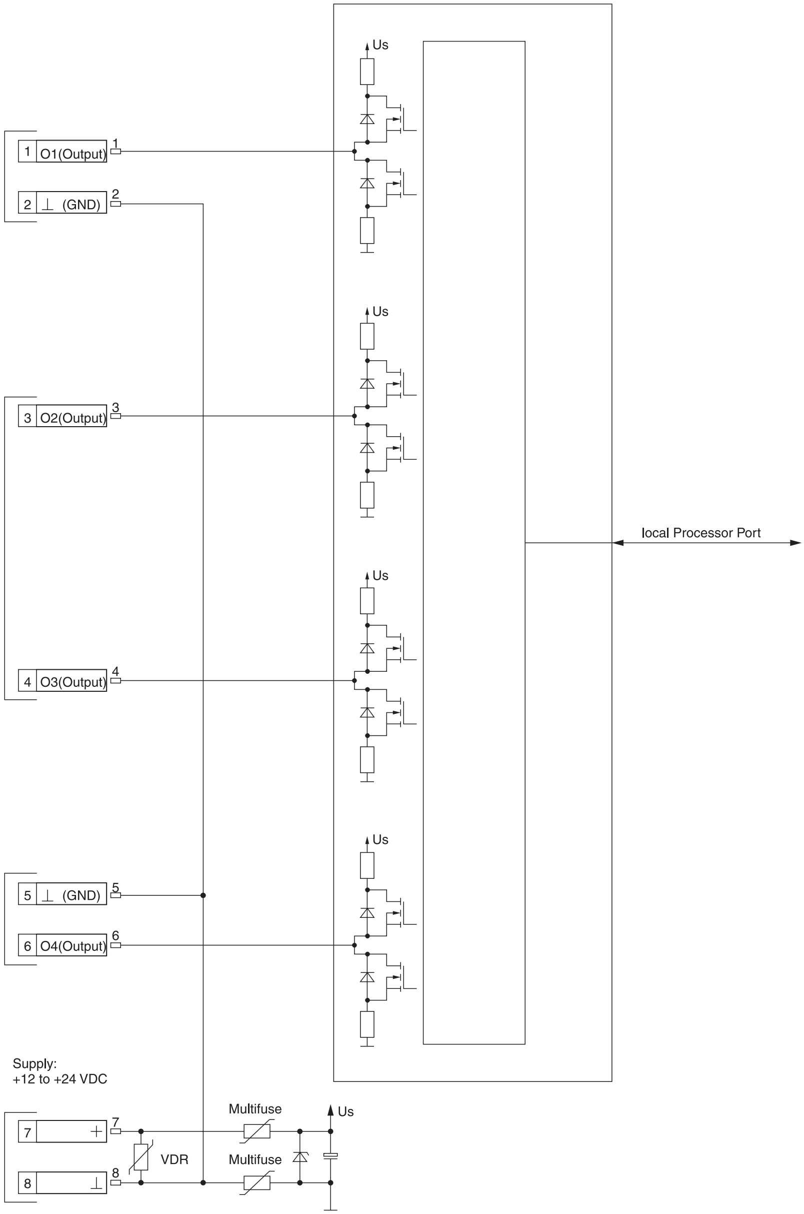

### TPU Operation

In TPU operation, the outputs are controlled by the TPU. If e.g. the DO135 module is inserted in the first slot of the CP interface, the first output can be operated using the LTX function LTXdo0().

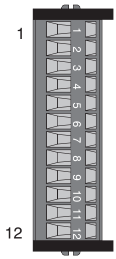
## 8.6.4 Special Functions

- The supply voltage is tested over a valid range. (10.5 VDC < Us < 30 VDC)
- The channels are equipped with readable power cut-off

## 8.6.5 Output Circuit Diagram



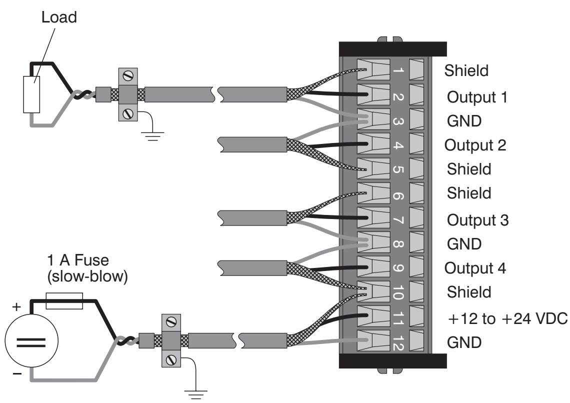
## 8.6.6 Connections




TB712

| Pin | Assignment |
|---|---|
| 1 | Shield |
| 2 | Output 1 |
| 3 | GND |
| 4 | Output 2 |
| 5 | Shield |
| 6 | Shield |
| 7 | Output 3 |
| 8 | GND |
| 9 | Output 4 |
| 10 | Shield |
| 11 | +12 to +24 VDC |
| 12 | GND |

## 8.6.7 Connection Example




Supply:

12 to 24 VDC
Protect with 1 A slow-blow fuse!

### 8.6.8 Variable Declaration

The variable declaration is valid for the following controllers:

- 2003 PCC CPU
- Remote I/O Bus Controller
- CAN Bus Controller

The variable declaration is made in PG2000. The variable declaration is described in Chapter 4, "Module Addressing".

Automation Studio™ Support: See Automation Studio™ Help starting with V 1.40

Accessing screw-in modules is also explained in the sections "AF101" and "CPU".

Data access takes place using data and configuration words. The following table provides an overview of which data and configuration words are used for this module.

| Data Access | VD Data Type | VD Module Type | VD Chan. | R | W | Description |
|---|---|---|---|---|---|---|
| Data word 0 | WORD | Analog In | 1 | ● | | Switching phase counter for all channels (pulse width modulation) |
| | INT16 | Analog Out | 1 | | ● | Output state or pulse width ratio for output 1 |
| Data word 1 | INT16 | Analog Out | 2 | | ● | Output state or pulse width ratio for output 2 |
| Data word 2 | INT16 | Analog Out | 3 | | ● | Output state or pulse width ratio for output 3 |
| Data word 3 | INT16 | Analog Out | 4 | | ● | Output state or pulse width ratio for output 4 |
| Configuration word 8 | WORD | Transp. Out | 16 | | ● | Period time |
| Configuration word 9 | WORD | Transp. Out | 18 | | ● | Factor for period time |
| Configuration word 12 | WORD | Transp. In | 24 | ● | | Module status |
| Configuration word 14 | WORD | Transp. In | 28 | ● | | Module type |
| | WORD | Transp. Out | 28 | | ● | Module configuration |

### 8.6.9 Access Using CAN IDs

Access via CAN Identifiers is used if the slave is being controlled by a device from another manufacturer.
Access via CAN Identifiers is described in an example in Chapter 4, "Module Addressing".
The transfer modes are explained in Chapter 5, "CAN Bus Controller Functions".

#### Input Data (switching phase counter)

The switching phase counter can be transferred packed or unpacked in pulse width modulation operating mode.
CAN objects can only be sent back in packed mode.

| CAN ID [1] | Slot 1 | | Slot 2 | | Slot 3 | | Slot 4 | |
|---|---|---|---|---|---|---|---|---|
| 542 | ScrM 1L | ScrM 1H | ScrM 2L | ScrM 2H | ScrM 3L | ScrM 3H | ScrM 4L | ScrM 4H |
| 543 | free | | | | | | | |
| 544 | free | | | | | | | |
| 545 | free | | | | | | | |

[1] CAN ID = 542 + (nd - 1) x 16 + (ma - 1) x 4
nd ..... Node number of the CAN slave = 1
ma .... Module address of the AF101 = 1

Four CAN objects can be sent back in unpacked mode.

| Slot | CAN ID [1] | Word 1 | | Word 2 | Word 3 | Word 4 |
|---|---|---|---|---|---|---|
| 1 | 542 | ScrM 1L | ScrM 1H | Not used (2 byte objects) | | |
| 2 | 543 | ScrM 2L | ScrM 2H | Not used (2 byte objects) | | |
| 3 | 544 | ScrM 3L | ScrM 3H | Not used (2 byte objects) | | |
| 4 | 545 | ScrM 4L | ScrM 4H | Not used (2 byte objects) | | |

[1] CAN ID = 542 + (nd - 1) x 16 + (ma - 1) x 4 + (sl - 1)
nd ..... Node number of the CAN slave = 1
ma .... Module address of the AF101 = 1
sl ....... Slot number of the screw-in module on the AF101 (1 - 4)

**Output Data**

It is not possible to pack output data with the DO135. Therefore one CAN object is transferred per screw-in module.
If an adapter module AF101 is equipped with a four DO135 modules, the CAN object has the following structure:

| Slot | CAN ID [1] | Word 1 | | Word 2 | | Word 3 | | Word 4 | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1054 | Chan. 1L | Chan. 1H | Chan. 2L | Chan. 2H | Chan. 3L | Chan. 3H | Chan. 4L | Chan. 4H |
| 2 | 1055 | Chan. 1L | Chan. 1H | Chan. 2L | Chan. 2H | Chan. 3L | Chan. 3H | Chan. 4L | Chan. 4H |
| 3 | 1056 | Chan. 1L | Chan. 1H | Chan. 2L | Chan. 2H | Chan. 3L | Chan. 3H | Chan. 4L | Chan. 4H |
| 4 | 1057 | Chan. 1L | Chan. 1H | Chan. 2L | Chan. 2H | Chan. 3L | Chan. 3H | Chan. 4L | Chan. 4H |

[1] CAN ID = 1054 + (nd - 1) x 16 + (ma - 1) x 4 + (sl - 1)
nd ..... Node number of the CAN slave = 1
ma .... Module address of the AF101 = 1
sl ....... Slot number of the screw-in module on the AF101 (1 - 4)

**B&R 2000 users have to exchange the data so that the high data is first (Motorola format)!**

For more information on ID allocation, see Chapter 5, "CAN Bus Controller Functions".

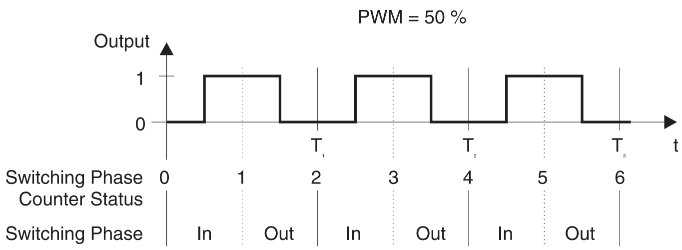
### 8.6.10 Description of Data and Configuration Words

**Data Word 0 (read)**

The switching phase of all channels in the pulse width modulation mode are counted with a 16-bit switching phase counter. The counter value can be read from data word 0.
It operates like a free running counter. This means that after reaching its highest value of 65535, the counter resets and begins again from 0.

The switching phase the output is currently in can be determined using the counter value.

Even Counter Value: Switch-on phase
Odd Counter Value: Switch-off phase




Switching Phase

In the switch-on phase (counter value is even), the output changes from OFF to ON. In the switch-off phase (counter value is odd), the output changes from ON to OFF.
The switching time is determined by the pulse width ratio.

**Data words 0, 1, 2, 3 (write)**

The output status and the pulse width ratio are defined with these data words according to the operating mode set.

Normal Operation

Bit 0 corresponds to the output state.

Output 1 = 0 ............ Data word 0 = $0000
Output 1 = 1 ............ Data word 0 = $0001
:                                   :
Output 4 = 0 ............ Data word 3 = $0000
Output 4 = 1 ............ Data word 3 = $0001

Pulse Width Modulation

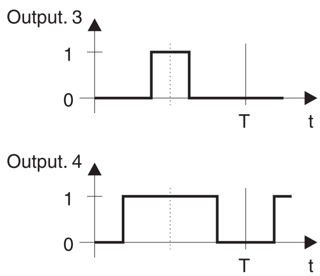
This operating mode defines the pulse width ratio.

32767 ($7FFF) ....... 100 %
0 ($0000) ........... 0 %
Neg. Values ........... 0 %

Example

Outputs 3 and 4 use operating mode pulse width modulation. The following pulse width ratios are defined:

Output 3 ......... 25 % => 25 % of 32767 = 8192 ($2000) in data word 2
Output 4 ......... 75 % => 75 % of 32767 = 24575 ($5FFF) in data word 3



**Configuration Word 8 (write)**

The period time is defined with configuration word 8. The period time depends on the factor used (see configuration word 9).

The standard value for the factor is 4. This results in the definition of the period time in milliseconds (0 - 65535).

If the period time is set to 0, the outputs keep their value after the current period has passed (normally log  0, only log  1 with a pulse width ratio of 100%). The period counter is then cleared and remains 0.

If the period time is changed to a value between 1 and 65535, the period counter will be stopped, cleared and restarted with the new value after the current period of the period counter.

<u>Period Time Unit</u>

The period time unit is calculated with the following formula:

Period time unit = 250 $\mu$s * factor

<u>Example</u>

A factor of 4 gives the following period time unit:

Period time unit= 250 $\mu$s * 4 = 1 ms

**Configuration Word 9 (write)**

The factor for the period time is defined with configuration word 9 (see configuration word 8).

The standard value for the factor is 4. This results in the definition of the period time in milliseconds.

The range of values lays between 1 and 256.
Larger values are limited to 256.

0 will be set to 256!

<u>Pulse Width Modulation Resolution</u>

Pulse width modulation resolution is calculated using the following formula:

PWM resolution = 125 $\mu$s * factor

The PWM resolution corresponds to the smallest pulse time.

Example

A typical module frequency range between 0.1Hz and 10 Hz results in the following resolution with a factor of 4:

| Frequency | Period Time | Resolution | Smallest Pulse Width Ratio |
|---|---|---|---|
| 0.1 Hz | 10 s | 20000 Ticks | 0005 % |
| 10 Hz | 0.1 s | 200 Ticks | 0.5 % |

To double the resolution with the same effective value, the factor can be divided in half.

**Configuration word 12 (read)**

Configuration word 12 contains the module status.

| Bit | Description |
|---|---|
| 8 - 15 | x .... Not defined, masked out |
| 7 | 0 .... Supply voltage ≤30 V<br>1 .... Supply voltage >30 V |
| 6 | 0 .... Supply voltage ≥10.5 V<br>1 .... Supply voltage <10.5 V or current limitation has responded |
| 5 | 0 .... Half-period counter for pulse width modulation is counting<br>1 .... Half-period counter for pulse width modulation is not counting |
| 4 | x .... Not defined, masked out |
| 3 | Switching level output 4 |
| 2 | Switching level output 3 |
| 1 | Switching level output 2 |
| 0 | Switching level output 1 |

| 15 | | | | | | | 8 | 7 | | | | | | | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| x | x | x | x | x | x | x | x | | | | x | | | | |

**Configuration Word 14 (read)**

The High Byte of configuration word 14 defines the module code.

| Bit | Description |
|---|---|
| 8 - 15 | Module code = $14 |
| 0 - 7 | x ....Not defined, masked out |

| 15 | | | | | | | 8 | 7 | | | | | | | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | x | x | x | x | x | x | x | x |

**Configuration Word 14 (write)**

The module is configured using configuration word 14.

Channel is not active

All outputs are tristate when they are all set to operating mode "channel not active".

TPU Operation

The output state is defined with LTX functions (e.g. LTXdo0()) for outputs with this operating mode.

| Bit | Description |
|---|---|
| 8 - 15 | 0 |
| 6 - 7 | Operating mode for output 4<br>0.... Channel is not active<br>1.... Normal operation<br>2.... Pulse width modulation<br>3.... TPU operation |
| 4 - 5 | Operating mode for output 3<br>0.... Channel is not active<br>1.... Normal operation<br>2.... Pulse width modulation<br>3.... TPU operation |
| 2 - 3 | Operating mode for output 2<br>0.... Channel is not active<br>1.... Normal operation<br>2.... Pulse width modulation<br>3.... TPU operation |
| 0 - 1 | Operating mode for output 1<br>0.... Channel is not active<br>1.... Normal operation<br>2.... Pulse width modulation<br>3.... TPU operation |

| 15 | | | | | | | 8 | 7 | | | | | | | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | |